

WHAT IS CLAIMED IS:

1. A filtering apparatus calculating a median of  $N$  pixel values arranged in a two-dimensional area of  $K \times K$  ( $K$  is an odd number not smaller than 3) of a digitized image, comprising:

receiving means for receiving said  $N$  pixel values;

5 removing means for removing, from said received  $N$  pixel values, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and

10 sorting means for outputting, among  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values by said removing means, first pixel value as sorted in accordance with said prescribed order as said median.

2. The filtering apparatus according to claim 1, wherein said prescribed order is either ascending order or descending order.

3. The filtering apparatus according to claim 1, wherein said receiving means has

dividing means for dividing said received  $N$  pixel values into  $K$  groups each consisting of  $K$  pixel values, and

5 group sorting means, for each of said  $K$  groups obtained by the division by said dividing means, for receiving and sorting the pixel values of the group in accordance with said prescribed order and outputting to said removing means;

10 said removing means has a plurality of cascade-connected pixel removing units for removing  $(N-1)/2$  pixel values from said  $N$  pixel values; each of said pixel removing units has

a determining unit determining, among first pixel values in accordance with said prescribed order of respective ones of said  $K$  groups applied, at least one first and following pixel values in accordance with the prescribed order, and

15 a shift storing unit receiving, temporarily storing and outputting

said pixel values of said K groups; and

20       said shift storing unit removes, in said group including said pixel value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

25       4. A filtering apparatus calculating a median of N pixel values arranged in a two-dimensional area of  $K \times K$  (K is an odd number not smaller than 3) of a digitized image, comprising:

30       receiving means for receiving said N pixel values;  
removing means for removing, from said received N pixel values,  $((N-1)/2+2)$  to Nth pixel values as sorted in accordance with a prescribed order;  
and

sorting means for outputting, among  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values by said removing means,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as said median.

5. The filtering apparatus according to claim 4, wherein said prescribed order is either ascending order or descending order.

6. The filtering apparatus according to claim 4, wherein said receiving means has

dividing means for dividing said received N pixel values into K groups each consisting of K pixel values, and

5       group sorting means, for each of said K groups obtained by the division by said dividing means, for receiving and sorting the pixel values of the group in accordance with said prescribed order and outputting to said removing means;

10       said removing means has a plurality of cascade-connected pixel removing units for removing  $(N-1)/2$  pixel values from said N pixel values;  
each of said pixel removing units has

a determining unit determining, among first pixel values in accordance with said prescribed order of respective ones of said K groups applied, at least one first and following pixel values in accordance with the prescribed order, and

15 a shift storing unit receiving, temporarily storing and outputting said pixel values of said K groups; and

said shift storing unit removes, in said group including said pixel value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

20 7. A filtering apparatus calculating, where a plurality of local areas including N pixel values of  $K \times K$  (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, comprising:

5 receiving means for receiving pixel values of said prescribed area and for outputting, for each of said plurality of local areas, N pixel values included in the local area; and

median extracting means corresponding to each of said plurality of local areas; wherein

10 said median extracting means has

removing means, receiving from said receiving means N pixel values included in corresponding said local area, for removing, from the input pixel values, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order, and

15 sorting means for outputting, among  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values by said removing means, first pixel value as sorted in accordance with said prescribed order, as said median.

8. The filtering apparatus according to claim 7, wherein said prescribed order is either ascending order or descending order.

9. The filtering apparatus according to claim 7, wherein  
said receiving means has  
dividing means for dividing said received pixel values of said local  
areas into a plurality of groups each consisting of K pixel values, and  
5 group sorting means, for each of said plurality of groups obtained by  
the division by said dividing means, for receiving and sorting the pixel  
values of the group in accordance with said prescribed order and outputting  
to said removing means corresponding to said local area to which the group  
belongs;  
10 said removing means has a plurality of cascade-connected pixel  
removing units for removing  $(N-1)/2$  pixel values from said N pixel values;  
each of said pixel removing units has  
a determining unit determining, among first pixel values in  
accordance with said prescribed order of respective ones of said K groups  
15 applied, at least one first and following pixel values in accordance with said  
prescribed order, and  
a shift storing unit receiving, temporarily storing and outputting  
said pixel values of said K groups; and  
said shift storing unit removes, in said group including said pixel  
20 value determined by said determining unit, said determined pixel value  
from said pixel values of the stored group, and shifts order of the second  
and the following pixel values remaining after the removal in accordance  
with said prescribed order before outputting.

10. A filtering apparatus calculating, where a plurality of local  
areas including N pixel values of  $K \times K$  (K is an odd number not smaller  
than 3) are arranged overlapped with each other in a prescribed area of a  
digitized image, a median of N pixel values of each of the local areas,  
5 comprising:  
receiving means for receiving pixel values of said prescribed area and  
for outputting, for each of said plurality of local areas, N pixel values  
included in the local area; and  
median extracting means corresponding to each of said plurality of

10 local areas; wherein  
said median extracting means has  
removing means, receiving from said receiving means  $N$  pixel values  
included in corresponding said local area, for removing, from the received  
pixel values,  $((N-1)/2)+2$ th to  $N$ th pixel values as sorted in accordance with  
15 a prescribed order, and  
sorting means outputting, among  $(N-(N-1)/2)$  pixel values remaining  
after removal of the pixel values by said removing means,  $(N-(N-1)/2)$ th  
pixel value as sorted in accordance with said prescribed order, as said  
median.

11. The filtering apparatus according to claim 10, wherein  
said prescribed order is either ascending order or descending order.

12. The filtering apparatus according to claim 10, wherein  
said receiving means has  
dividing means for dividing said received pixel values of said local  
areas into a plurality of groups each consisting of  $K$  pixel values, and  
5 group sorting means, for each of said plurality of groups obtained by  
the division by said dividing means, for receiving and sorting the pixel  
values of the group in accordance with said prescribed order and outputting  
to said removing means corresponding to said local area to which the group  
belongs;  
10 said removing means has a plurality of cascade-connected pixel  
removing units for removing  $(N-1)/2$  pixel values from said  $N$  pixel values;  
each of said pixel removing units has  
a determining unit determining, among first pixel values in  
accordance with said prescribed order of respective ones of said  $K$  groups  
15 applied, at least one first and following pixel values in accordance with said  
prescribed order, and  
a shift storing unit receiving, temporarily storing and outputting  
said pixel values of said  $K$  groups; and  
said shift storing unit removes, in said group including said pixel

20 value determined by said determining unit, said determined pixel value from said pixel values of the stored group, and shifts order of the second and the following pixel values remaining after the removal in accordance with said prescribed order before outputting.

13. A data driven type information processing apparatus including operating means receiving a packet having at least a destination field storing destination information, an instruction field storing instruction information and data field storing data, for executing an operation in  
5 accordance with a data flow program using the received packet, wherein said operating means has  
filtering operation means for performing an operation in accordance with a median filtering instruction instructing calculation of a median of N pixel values arranged in a two-dimensional area of K\*K (K is an odd  
10 number not smaller than 3) of a digitized image, means for other operations, and branching means for outputting, based on said instruction information of said received packet, said received packet either to said filtering operation means or said means for other operations;  
said filtering operation means includes  
15 removing means for removing, from said N pixel values in said data field of said received packet, first to  $(N-1)/2$ th pixel values as sorted in accordance with a prescribed order, and  
sorting means for storing, among  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values by said removing means, first pixel value  
20 as sorted in accordance with said prescribed order, as said median in said data field of said packet and outputting said packet.

14. The data driven type information processing apparatus according to claim 13, wherein  
said prescribed order is either ascending order or descending order.

15. The data driven type information processing apparatus according to claim 13, further comprising:

program storing means for storing said data flow program including  
a plurality of pieces of said destination information and a plurality of pieces  
5 of said instruction information, receiving said packet, reading subsequent  
said destination information and subsequent said instruction information  
from said data flow program, storing the read information to said  
destination field and said instruction field of the received packet,  
respectively, and outputting the received packet;  
10 pair data detecting means for receiving said packet output from said  
program storing means, storing contents necessary to execute said  
instruction information of said instruction field of the received packet and  
outputting the received packet to said operating means; and  
input/output control means for receiving said packet output from  
15 said operating means, and outputting to the outside or to said program  
storing means.

16. A data driven type information processing apparatus including  
operating means receiving a packet having at least a destination field  
storing destination information, an instruction field storing instruction  
information and data field storing data, for executing an operation in  
5 accordance with a data flow program using the received packet, wherein  
said operating means has  
filtering operation means for performing an operation in accordance  
with a median filtering instruction instructing calculation of a median of N  
pixel values arranged in a two-dimensional area of  $K \times K$  (K is an odd  
10 number not smaller than 3) of a digitized image, means for other operations,  
and branching means for outputting, based on said instruction information  
of said input packet, said received packet either to said filtering operation  
means or said means for other operations;  
said filtering operation means includes  
15 removing means for removing, from said N pixel values in said data  
field of said received packet,  $((N-1)/2)+2$  to Nth pixel values as sorted in  
accordance with a prescribed order, and  
sorting means for storing, among  $(N-(N-1)/2)$  pixel values remaining

20 after removal of the pixel values by said removing means,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median in said data field of said packet and outputting said packet.

17. The data driven type information processing apparatus according to claim 16, further comprising:

5 program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10 pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

15 input/output control means for receiving said packet output from said operating means, and outputting to the outside or to said program storing means.

5 18. A data driven type information processing apparatus including operating means receiving as a packet having at least a destination field storing destination information, an instruction field storing instruction information and data field storing data, for executing an operation in accordance with a data flow program using the received packet, wherein said operating means has

10 filtering operation means for performing an operation in accordance with a median filtering instruction instructing, where a plurality of areas including  $N$  pixel values of  $K \times K$  ( $K$  is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, calculation of a median of  $N$  pixel values of each of the areas, means for other operations, and branching means for outputting, based on said instruction information



of said received packet, said received packet either to said filtering operation means or said means for other operations;

15        said filtering operation means includes

receiving means for inputting pixel values of said plurality of local areas of said data field of said received packet, and outputting, for each of said plurality of local areas, a packet having N pixel values included in the local area stored in the data field, and

20        median extracting means corresponding to each of said plurality of local areas; and

      said median extracting means includes

25        removing means, receiving from said ~~input~~<sup>receiving</sup> means a packet storing N pixel values included in corresponding said area, for removing, from the input pixel values, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order, and

30        sorting means for extracting, among  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values by said removing means in the data field of said packet, first pixel value as sorted in accordance with said prescribed order, as said median, storing the median in said data field of said packet and outputting the packet.

19. The data driven type information processing apparatus according to claim 18, further comprising:

5        program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10        pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

input/output control means for receiving as an input said packet  
15 output from said operating means, and outputting to the outside or to said  
program storing means.

20. A data driven type information processing apparatus including  
operating means receiving a packet having at least a destination field  
storing destination information, an instruction field storing instruction  
information and data field storing data, for executing an operation in  
5 accordance with a data flow program using the received packet, wherein  
said operating means has

filtering operation means for performing an operation in accordance  
with a median filtering instruction instructing, where a plurality of local  
areas including N pixel values of  $K \times K$  (K is an odd number not smaller  
10 than 3) are arranged overlapped with each other in a prescribed area of a  
digitized image, calculation of a median of N pixel values of each of the  
local areas, means for other operations, and branching means for  
outputting, based on said instruction information of said received packet,  
said received packet either to said filtering operation means or said means  
15 for other operations;

said filtering operation means includes  
receiving means for inputting pixel values of said prescribed area of  
said data field of received said packet, and outputting, for each of said  
plurality of local areas, a packet having N pixel values included in the local  
20 area stored in the data field, and

median extracting means corresponding to each of said plurality of  
local areas; and

said median extracting means includes  
removing means, receiving from said receiving means a packet  
25 storing N pixel values included in corresponding said local area, for  
removing, from the input pixel values,  $((N-1)/2)+2$ th to Nth pixel values as  
sorted in accordance with a prescribed order, and

sorting means for extracting, among  $(N-(N-1)/2)$  pixel values  
remaining after removal of the pixel values by said removing means in the

30 data field of said packet,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median, storing the median in said data field of said packet and outputting the packet.

21. The data driven type information processing apparatus according to claim 20, wherein  
said prescribed order is either ascending order or descending order.

22. The data driven type information processing apparatus according to claim 20, further comprising:

5 program storing means for storing said data flow program including a plurality of pieces of said destination information and a plurality of pieces of said instruction information, receiving said packet, reading subsequent said destination information and subsequent said instruction information from said data flow program, storing the read information to said destination field and said instruction field of the received packet, respectively, and outputting the received packet;

10 pair data detecting means for receiving said packet output from said program storing means, storing contents necessary to execute said instruction information of said instruction field of the received packet and outputting the received packet to said operating means; and

15 input/output control means for receiving said packet output from said operating means, and outputting to the outside or to said program storing means.

23. A filtering method for calculating a median of  $N$  pixel values arranged in a two-dimensional area of  $K \times K$  ( $K$  is an odd number not smaller than 3) of a digitized image, comprising:

5 the receiving step of receiving said  $N$  pixel values;  
the removing step of removing, from said  $N$  pixel values received in said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and  
the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values

10 remaining after the removal of the pixel values in said removing step, first  
pixel value as sorted in accordance with said prescribed order as said  
median.

24. A filtering method for calculating a median of N pixel values  
arranged in a two-dimensional area of  $K \times K$  (K is an odd number not  
smaller than 3) of a digitized image, comprising:

5 the receiving step of receiving said N pixel values;  
the removing step of removing, from said N pixel values received in  
said receiving step,  $((N-1)/2)+2$  to Nth pixel values as sorted in accordance  
with a prescribed order; and

10 the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values  
remaining after removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as  
said median.

25. A program product to have a computer execute a filtering  
method, wherein

5 said filtering method is for calculating a median of N pixel values  
arranged in a two-dimensional area of  $K \times K$  (K is an odd number not  
smaller than 3) of a digitized image, including:

the receiving step of receiving said N pixel values;  
the removing step of removing, from said N pixel values received in  
said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance  
with a prescribed order; and  
10 the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values  
remaining after removal of the pixel values in said removing step, first  
pixel value as sorted in accordance with said prescribed order as said  
median.

26. A program product to have a computer execute a filtering  
method, wherein

said filtering method is for calculating a median of N pixel values

- 5 arranged in a two-dimensional area of  $K \times K$  ( $K$  is an odd number not smaller than 3) of a digitized image, including:
- the receiving step of receiving said  $N$  pixel values;
  - the removing step of removing, from said  $N$  pixel values received in said receiving step,  $((N-1)/2)+2$  to  $N$ th pixel values as sorted in accordance with a prescribed order; and
  - 10 the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order as said median.

27. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein
- said filtering method is for calculating a median of  $N$  pixel values arranged in a two-dimensional area of  $K \times K$  ( $K$  is an odd number not
- 5 smaller than 3) of a digitized image, including:
- the receiving step of receiving said  $N$  pixel values;
  - the removing step of removing, from said  $N$  pixel values received in said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and
  - 10 the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

28. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein
- said filtering method is for calculating a median of  $N$  pixel values arranged in a two-dimensional area of  $K \times K$  ( $K$  is an odd number not
- 5 smaller than 3) of a digitized image, including:
- the receiving step of receiving said  $N$  pixel values;
  - the removing step of removing, from said  $N$  pixel values received in said receiving step,  $((N-1)/2)+2$  to  $N$ th pixel values as sorted in accordance

with a prescribed order; and

10        the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.

29. A filtering method of calculating, where a plurality of areas including  $N$  pixel values of  $K \times K$  ( $K$  is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, a median of  $N$  pixel values of each of the areas, comprising:

5        the receiving step of receiving the pixel values of said plurality of areas, and outputting, for each of said plurality of areas,  $N$  pixel values included in the area; and

the median extracting step of extracting the median corresponding to each of said plurality of areas; wherein

10        said median extracting step includes

the removing step of removing, from said  $N$  pixel values included in corresponding said area and received in said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and

15        the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after the removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

30. A filtering method of calculating, where a plurality of local areas including  $N$  pixel values of  $K \times K$  ( $K$  is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of  $N$  pixel values of each of the local areas, comprising:

5        the receiving step of receiving the pixel values of said prescribed area, and outputting, for each of said plurality of local areas,  $N$  pixel values included in the local area; and

the median extracting step of extracting the median corresponding to

10 each of said plurality of local areas; wherein  
said median extracting step includes  
the removing step of removing, from said N pixel values included in  
corresponding said local area and received in said receiving step,  $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed  
15 order; and  
the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values  
remaining after the removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as  
said median.

31. A program product to have a computer execute a filtering  
method, wherein

5 said filtering method is for calculating, where a plurality of areas  
including N pixel values of  $K \times K$  (K is an odd number not smaller than 3)  
are arranged overlapped with each other in a digitized image, a median of  
N pixel values of each of the local areas, including:

the receiving step of receiving the pixel values of said plurality of  
areas, and outputting, for each of said plurality of areas, N pixel values  
included in the area; and

10 the median extracting step of extracting the median corresponding to  
each of said plurality of areas; wherein

said median extracting step includes

the removing step of removing, from said N pixel values included in  
corresponding said area and received in said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and  
15

the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values  
remaining after the removal of the pixel values in said removing step, first  
pixel value as sorted in accordance with said prescribed order, as said  
median.

32. A program product to have a computer execute a filtering  
method, wherein

5        said filtering method is for calculating, where a plurality of local areas including N pixel values of  $K \times K$  (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, including:

10        the receiving step of receiving as inputs the pixel values of said prescribed area, and outputting, for each of said plurality of local areas, N pixel values included in the local area; and

      the median extracting step of extracting the median corresponding to each of said plurality of local areas; wherein

      said median extracting step includes

15        the removing step of removing, from said N pixel values included in corresponding said local area and received in said receiving step,  $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed order; and

20        the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after the removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.

33. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein

5        said filtering method is for calculating, where a plurality of areas including N pixel values of  $K \times K$  (K is an odd number not smaller than 3) are arranged overlapped with each other in a digitized image, a median of N pixel values of each of the areas, including:

10        the receiving step of receiving the pixel values of said plurality of areas, and outputting, for each of said plurality of areas, N pixel values included in the area; and

      the median extracting step of extracting the median corresponding to each of said plurality of areas; wherein

      said median extracting step includes

      the removing step of removing, from said N pixel values included in



15 corresponding said area and received in said receiving step, first to  $((N-1)/2)$ th pixel values as sorted in accordance with a prescribed order; and  
the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after the removal of the pixel values in said removing step, first pixel value as sorted in accordance with said prescribed order, as said median.

34. A machine readable recording medium recording a program to have a computer execute a filtering method, wherein

5 said filtering method is for calculating, where a plurality of local areas including N pixel values of  $K \times K$  (K is an odd number not smaller than 3) are arranged overlapped with each other in a prescribed area of a digitized image, a median of N pixel values of each of the local areas, including:

10 the receiving step of receiving the pixel values of said prescribed area, and outputting, for each of said plurality of local areas, N pixel values included in the local area; and

the median extracting step of extracting the median corresponding to each of said plurality of local areas; wherein

said median extracting step includes

15 the removing step of removing, from said N pixel values included in corresponding said local area and received in said receiving step,  $((N-1)/2)+2$ th to Nth pixel values as sorted in accordance with a prescribed order; and

20 the sorting step of outputting, among the  $(N-(N-1)/2)$  pixel values remaining after the removal of the pixel values in said removing step,  $(N-(N-1)/2)$ th pixel value as sorted in accordance with said prescribed order, as said median.